United States Environmental Protection Agency
Washington, DC 20460

# Work Assignment

Work Assignment Number: 1-37
● Original
○ Amendment

Contract Number: EP-C-09-027
Contract Period: 04/01/2010 - 03/31/2011
Option Period No. 1
SF Site Name:

Title of Work Assignment: Characterization of Hg Emissions from Artisanal Gold Mining Shops

Suggested Source: Arcadis
Specify Section & Paragraph of Contract SOW: 1.8, 2.0A, 4.0, 5.2, 6.0D, 7.0

Purpose:
● Work Assignment Initiation ○ Work Assignment Close-Out
○ Work Assignment Amendment ○ Incremental Funding
○ Work Plan Approval

Period of Performance
From: 07/22/2010 To: 03/31/2011

Comments:

QA Category (check one)
○ I Enforcement
○ II Standard Setting
○ III Technology Development
● IV Proof of Concept
○ N/A

*Note: To report additional accounting and appropriations data use EPA Form 1900-69A.*

SFO 22 (Max 2) ☐ Superfund ☐ Non-Superfund

## Accounting and Appropriations Data

| | DCN (Max 6) | Budget/FYs (Max 4) | Appropriation Code (Max 6) | Budget Org/Code (Max 7) | Program Element (Max 9) | Object Class (Max 4) | Amount | Sites/Project (Max 8) | Cost Org/Code (Max 7) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |

## Authorized Work Assignment Ceiling

| Contract Period: | Cost/Fee | LOE |
|---|---|---|
| Previously Approved | New | 0 |
| This Action | | 0 |
| Total | | 0 |

## Work Plan / Cost Estimate Approvals

| | | | |
|---|---|---|---|
| Contractor WP Dated: | | Cost/Fee: | LOE: |
| Cumulative Approved: | | Cost/Fee: | LOE: |

| | | | |
|---|---|---|---|
| Work Assignment Manager Name | Jeff Ryan | Branch / Mail Code | APTB; NHSRC-DCMD; APB / E305-01; E343-06; E305-02 |
| (Signature) | (Date) 7/7/10 | Phone Number | (919) 541-1437; (919) 541-0699; (919) 541-4167 |
| | | Fax Number | |
| Branch Chief Name | Ravi Srivastava, Chief, APTB; Nancy Adams, Director, NHSRC-DCMD; Andy C. Miller, Chief, APB | Branch/Mail Code | APTB; NHSRC-DCMD; APB / E305-01; E343-06; E305-02 |
| Dennis J. Tafa For RKS (Signature) | (Date) 7/7/10 | Phone Number | (919) 541-3444; (919) 541-5510; (919) 541-2920 |
| | | Fax Number | |
| Project Officer Name | Diane Pierce | Branch/Mail Code | / |
| Diane L Pierce (Signature) | (Date) 7/21/10 | Phone Number | |
| | | Fax Number | |
| Contracting Official Name | Renita Tyus, CO | Branch/Mail Code | CPOD |
| Renita Tyus (Signature) | (Date) 7/22/10 | Phone Number | (513) 487-2094 |
| | | Fax Number | (513) 487-2109 |

Contractor Acknowledgement of Receipt and Approval of Workplan (Signature and Title) | Date

# Statement of Work
# for
# Characterization of Hg Emissions from Artisanal Gold Mining Shops

**Project Description:**

Background:

Artisanal and small scale gold mining (ASGM) represents one of the largest uses, for gold amalgamation, of mercury around the world. Moreover, this practice routinely results in significant emissions of Hg to the air. Unfortunately, very little is understood regarding the quantity and forms of these emissions. This project will obtain the first ever speciated (oxidized vs. elemental) mercury measurements at representative secondary refinement gold shops in order to provide a preliminary, rough assessment of the anticipated transport characteristics and spatial distribution of mercury emissions for selected Amazon and high altitude gold mining areas in Peru.

Typically, gold is "mined" in remote areas in Peru using a process where large quantities of metallic Hg (e.g., 10 kg) are placed in vessels containing raw ore and water. The vessel is agitated to maximize surface content of the Hg with the slurried ore. The gold in the slurry then forms an amalgam with the Hg resulting in a large "ball" that is removed by the miner. The miner then uses heat (e.g., open fire or blowtorch) to vaporize and drive off some of the Hg in the amalgam ball. In rare instances, a retort is used which enables some of the Hg to be captured for re-use. The amalgam ball is then transported to a central location for sale in a "Gold Shop". Gold Shops are commonly located in small cities or towns. These locations often have many shops. At these shops, the amalgam balls are further heated in a more controlled practice to drive off all remaining Hg, and leaving the pure gold for purchase by the shop. These shops process many amalgam balls per day and are often operated daily. As a result, significant Hg emissions are released in a relatively localized region, including within the shops themselves. While some preliminary field testing has been conducted to characterize these emissions, including a potential Hg control technology, more definitive Hg emissions characterizations are needed, including a determination of Hg species distribution.

Project Objectives:

This project has multiple objectives for multiple emissions data applications. The primary objective is to characterize the Hg emissions from artisanal gold mining shops and their activities. This will include real-time and time integrated measurements of direct and indirect process emissions, a determination of Hg species distribution, and a characterization of gold shop processing activities. The ultimate goal is to use this information to develop emission rates/emission factors such that local atmospheric modeling by OAQPS can be performed at the 2 regions/sites tested. This project is in direct support to EPA's Office of International and Tribal Affairs (OITA) and their collaboration with the United Nations Environment Programme (UNEP). Field testing is expected to take place in the September/October 2010 time frame.

**Statement of Work:**

**TASK 1.** Work Plan, Reporting, Budget, And WA Management

The contractor shall prepare and deliver to the WA manager (WAM) a work plan and budget within 20 days of WA effective date. The work plan must include a description of how the contractor shall accomplish each task, along with a breakdown of level of effort by professional level per task; a cost breakdown per task, and any underlying assumptions used. The contractor shall conduct activities necessary to manage the WA, including at least weekly communication with the EPA WAM.

**TASK 2.** Preparation of New WA QAPP

The contractor shall prepare and deliver a new WA QAPP. The QAPP shall be developed according to the requirements in Appendix #1 to this Statement of Work. Work involving environmental data shall not commence until the quality assurance documentation has received official approval from the EPA Quality Assurance Staff.

**TASK 3.** In-Country Coordination and Logistics

The contractor shall be responsible for coordinating the in-country testing logistics, including identifying appropriate candidate test sites (high altitude and Amazon). The candidates shall at least consider timely access, shop cooperation and those shops that have existing Hg controls. The contractor shall identify logistics required for shipping/transporting equipment to Peru and the candidate test sites. The contractor shall be the primary interface with local representatives and shall facilitate communications with EPA project representatives.

**TASK 4.** Identification and Pre-Trip Confirmation of Measurement Approaches

The field testing will require the measurement of relatively high Hg concentrations – on a real-time basis with a continuous analyzer as well as with the sorbent traps. Concentrations as high as 35 ug/m3 or greater are anticipated. These are well beyond the nominal measurement range for our Lumex system. The contractor shall develop and demonstrate approaches that allow measurements of these concentrations (e.g., dilution systems, shorter optical cells/path lengths). Proof –of-concept tests that confirm these approaches shall also be considered.

Speciated measurements will be a major emphasis of this test program. The contractor shall identify at least 2 approaches for performing speciated Hg measurements (with the KCl sorbent traps being at least one of them). At this time, only oxidized and elemental (gaseous) Hg measurements are required. However, PM or liquid aerosol measurements shall also be considered.

**TASK 5.** Gold Mining Shops Emissions Testing

The contractor shall travel to Peru and perform emissions testing in Gold Shops at 2 different locations. The testing will be performed in the Peruvian Amazon, in a community such as Puerto Maldonado and at altitude in the Andes, in a community such as Ananea, Puno. Priority shall be given to gold shops operating both without and with the EPA/Argonne gold shop mercury capture system (MCS) which has been piloted in Peru. (An MCS was installed by EPA/Argonne in Ananea, Puno in November 2009). Multiple shops will be tested at each location, and samples will be analyzed back in the U.S. lab.

The contractor shall develop a strategy for determining the mass emissions from representative gold shop operations – from individual thermal gold amalgam treatments, as well as as an assessment of activity factors. The desired product is a community-specific Hg mass emission rate, including speciation, that can be used my atmospheric modelers. In addition, speciated Hg emissions measurements will be made within the ambient environment of the gold shops to aid in speciation measurements, as well as provide an indication of worker exposure levels.

For planning purposes, the contractor shall assume that a total of 3 weeks travel will be appropriate for this WA. The point of country entry will be Lima, Peru and that at least 3 days of testing will be required in each test community. Testing is expected to take place in September or October, 2010. Testing will not occur prior to September 1, 2010.

**TASK 6.** Draft and Final Reports

Several data reports are required as a function of this WA. Known reports include, but are not limited to: Draft Data - Test data summaries for each location, brief summaries of associated testing activities and procedures, copies of all ancillary data forms and log sheets (within 60 days of completion of testing); Final Data Report – All raw and summarized measurements data, QA/QC report of data quality and data limitations, if any. (TBD)

**QA/QC Requirements**

A QAPP will be required for this WA. The QAPP shall be developed according to the requirements in Appendix #1 to this Statement of Work. Work involving environmental data shall not commence until the quality assurance documentation has received official approval from the EPA Quality Assurance Staff.

**Reports of Work:**

The contractor shall prepare a work plan and budget as described in Task 1 within 20 days of WA effective date. The contractor shall prepare and submit monthly reports in accordance with the terms and conditions of the contract.

Health and Safety Protocols shall be prepared and submitted for approval as required by contractor, APPCD, and SHEM safety personnel.

The contractor shall maintain at least weekly communications with the WAM. Additionally the contractor shall inform the PO and the WAM in writing when 75% of the total funds and/or hours contained in the work plan are expended.

# ATTACHMENT #1 TO THE STATEMENT OF WORK (SOW) FOR MEASUREMENT & METHOD DEVELOPMENT PROJECTS

## NRMRL Quality Assurance (QA) Requirements

In accordance with EPA Order 5360.1 A2, conformance to ANSI/ASQC E4 must be demonstrated by submitting the quality documentation specified herein. All quality documentation shall be submitted to the Government for review. The Government will review and return the quality documentation, with comments, and indicate approval or disapproval. If the quality documentation is not approved, it must be revised to address all comments and shall be resubmitted to the Government for approval. Work involving environmental data collection, generation, use, or reporting shall not commence until the Government has approved the quality documentation. The quality documentation shall be submitted to the Government at least thirty (30) days prior to the beginning of any environmental data gathering or generation activity in order to allow sufficient time for review and revisions to be completed. After the Government has approved the quality documentation, the Contractor shall also implement it as written and approved by the Government. Any EPA-funded project/program may be subject to a QA audit.

**TO BE SUBMITTED PRE-AWARD (mark all that apply):**

☐ **NRMRL's Quality System Specifications:**

(1) a description of the organization's Quality System (QS) and information regarding how this QS is documented, communicated and implemented;
(2) an organizational chart showing the position of the QA function;
(3) delineation of the authority and responsibilities of the QA function;
(4) the background and experience of the QA personnel who will be assigned to the project; and
(5) the organization's general approach for accomplishing the QA specifications in the SOW.

☐ **Quality Management Plan:** prepared in accordance with R-2 - EPA Requirements for Quality Management Plans (EPA/240/B-01/002) March, 2001, http://www.epa.gov/quality/qs-docs/r2-final.pdf

**TO BE SUBMITTED POST-AWARD (mark all that apply):**

☐ **NRMRL's Quality System Specifications:**

(1) a description of the organization's Quality System (QS) and information regarding how this QS is documented, communicated and implemented;
(2) an organizational chart showing the position of the QA function; 07/14/08 A-2
(3) delineation of the authority and responsibilities of the QA function;
(4) the background and experience of the QA personnel who will be assigned to the project; and
(5) the organization's general approach for accomplishing the QA specifications in the SOW.

☐ **Quality Management Plan:** prepared in accordance with R-2 - EPA Requirements for Quality Management Plans (EPA/240/B-01/002) March, 2001, http://www.epa.gov/quality/qs-docs/r2-final.pdf

☐ **Category I or II Quality Assurance Project Plan (QAPP):** prepared in accordance with R-5 - EPA Requirements for QA Project Plans (EPA/240/B-01/003) March, 2001 http://www.epa.gov/quality/qs-docs/r5-final.pdf

X **Category III or IV QAPP:** prepared in accordance with applicable sections of the following NRMRL QAPP Requirements List(s) which is(are) included in this attachment:

X **QAPP Requirements for Measurement Projects**

□ **QAPP Requirements for Secondary Data Projects**

□ **QAPP Requirements for Research Model Development and/or Application Projects**

□ **QAPP Requirements for Software Development Projects**

X **QAPP Requirements for Method Development Projects**

□ **QAPP Requirements for Design, Construction, and/or Operation of Environmental Technology Projects**

**ADDITIONAL QA RESOURCES:**

EPA's Quality System Website: http://www.epa.gov/quality/
EPA's Requirements and Guidance Documents: http://www.epa.gov/quality/qa_docs.html

---

## NRMRL QAPP REQUIREMENTS FOR MEASUREMENT PROJECTS

**GENERAL REQUIREMENTS:**

Include cover page, distribution list, approvals, and page numbers.

**0. COVER PAGE**

Include the Division/Branch, project title, revision number, EPA technical lead, QA category, organization responsible for QAPP preparation, and date.

**1. PROJECT DESCRIPTION AND OBJECTIVES**

1.1 Describe the process and/or environmental system to be evaluated.
1.2 State the purpose of the project and list specific project objective(s).

**2. ORGANIZATION AND RESPONSIBILITIES**

2.1 Identify all project personnel, including QA, and related responsibilities for each participating organization, as well as their relationship to other project participants.
2.2 Include a project schedule that includes key milestones.

**3. SCIENTIFIC APPROACH**

3.1 Describe the sampling and/or experimental design that will be used to generate the data needed to evaluate the projective objective(s). A description of the design should include the types and numbers of samples (including QC and reserve samples), the design of the sampling network, sample locations and frequencies, and the rationale for the design.
3.2 Identify the process measurements (e.g., flow rate, temperature) and specific target analyte(s) for each sample type.
3.3 Describe the general approach and the test conditions for each experimental phase.

**4. SAMPLING PROCEDURES**

4.1 Describe any known site-specific factors that may affect sampling procedures as well as all site preparation (e.g., sampling device installation, sampling port modifications, achievement of steady-state) needed prior to sampling.
4.2 Describe or reference each sampling procedure (including a list of equipment needed and the calibration of this equipment as appropriate) to be used. Include procedures for homogenizing, compositing, or splitting of samples, as applicable.
4.3 Provide a list of sample containers, sample quantities to be collected, and the sample amount required for each analysis, including QC sample analysis.
4.4 Specify sample preservation requirements (e.g., refrigeration, acidification, etc.) and holding times.
4.5 Describe the method for uniquely numbering each sample.
4.6 Describe procedures for packing and shipping samples, including procedures to avoid cross-contamination, and provisions for maintaining chain-of-custody (e.g., custody seals and records), as applicable.

## 5 MEASUREMENT PROCEDURES

5.1 Describe in detail or reference each process measurement or analytical method to be used. If applicable, identify modifications to EPA-approved or similarly validated methods.
5.2 If not provided in Section 5.1 or the referenced method, include specific calibration procedures, including linearity checks and initial and continuing calibration checks.

## 6 QUALITY METRICS (QA/QC CHECKS)

6.1 For each process measurement and analytical method, identify the required QC checks (e.g., blanks, control samples, duplicates, matrix spikes, surrogates), the frequencies for performing these checks, associated acceptance criteria, and corrective actions to be performed if acceptance criteria are not met.
6.2 Any additional project-specific QA objectives (e.g., completeness, mass balance) shall be presented, including acceptance criteria.

## 7 DATA ANALYSIS, INTERPRETATION, AND MANAGEMENT

7.1 Identify the data reporting requirements, including data reduction procedures specific to the project and applicable calculations and equations.
7.2 Describe data validation procedures used to ensure the reporting of accurate project data.
7.3 Describe how the data will be summarized or analyzed (e.g., qualitative analysis, descriptive or inferential statistics) to meet the project objective(s).
7.3.1- If descriptive statistics are proposed, state what tables, plots, and/or statistics (e.g., mean, median, standard error, minimum and maximum values) will be used to summarize the data.
7.3.2- If an inferential method is proposed, indicate whether the method will be a hypothesis test, confidence interval, or confidence limit and describe how the method will be performed.
7.4 Describe data storage requirements for both hard copy and electronic data.

## 8 REPORTING

8.1 List and describe the deliverables expected from each project participant responsible for field and/or analytical activities.
8.2 Specify the expected final product(s) that will be prepared for the project (e.g., journal article, final report).

## 9. REFERENCES

Provide references either in the body of the text as footnotes or in a separate section.

## NRMRL QAPP REQUIREMENTS FOR METHOD DEVELOPMENT PROJECTS

### GENERAL REQUIREMENTS:

Include cover page, distribution list, approvals, and page numbers.

### 0. COVER PAGE

Include the Division/Branch, project title, revision number, EPA technical lead, QA category, organization responsible for QAPP preparation, and date.

### 1. PROJECT DESCRIPTION AND OBJECTIVES

1.1 Provide a description of the situation that requires the generation of a new or modified method.
1.2 State the purpose of the project and list specific project objective(s).

### 2. ORGANIZATION AND RESPONSIBILITIES

2.1 Identify all project personnel, including QA, and related responsibilities for each participating organization, as well as their relationship to other project participants.
2.2 Include a project schedule that includes key milestones.

### 3. SCIENTIFIC APPROACH

3.1 Identify the specific analyte(s) of interest and the matrix/matrices under study.
3.2 Identify the analytical approach that will be used and how it will be optimized for this study. Also describe any tests of interference and analyte stability.
3.2 Identify the method performance metrics (QA/QC checks) that will be used to evaluate the method, including the procedures used. These metrics could include (but are not limited to) positive and negative controls, sensitivity, precision, accuracy, recovery, linearity, specificity, robustness, and range.

### 4. SAMPLING PROCEDURES

4.1 Provide the requirements for samples that will be used to test the method (including matrix and presence/concentration of analytes).
4.2 If synthetic (i.e., laboratory-prepared) samples are used, describe the preparation of these samples.
4.3 If non-synthetic (i.e., real-world sample) samples are used, address the following:
- describe the sampling design that will be used and the steps taken to assure that representative samples are collected
- discuss or reference each sampling procedure
- provide a list of sample containers, sample quantities to be collected, and the sample amount required for each analysis, including QC sample analysis
- describe procedures for packing and shipping samples, and provisions for maintaining chain-of-custody, as applicable

4.4 Specify sample preservation requirements (e.g., refrigeration, acidification, etc.) and holding times.
4.5 Describe the method for uniquely numbering each sample.

### 5. MEASUREMENT PROCEDURES

5.1 Describe in detail or reference each preparation or analytical procedure to be used, if known. Include steps for preparation, calibration, measurement, quality control, and reporting.

5.2 If not provided in Section 5.1 or the referenced method, Include specific calibration procedures, including linearity checks and initial and continuing calibration checks.

**6. METHOD PERFORMANCE METRICS**

For each method performance metric (QA/QC check) identified in Section 3.2, specify the frequencies for performing these checks, associated acceptance criteria, and corrective actions to be performed if acceptance criteria are not met.

**7. DATA ANALYSIS, INTERPRETATION, AND MANAGEMENT**

7.1 Identify the data reporting requirements, including data reduction procedures specific to the project and applicable calculations and equations.
7.2 Describe data validation procedures used to ensure the reporting of accurate project data.
7.3 Describe how the data will be summarized or analyzed (e.g., qualitative analysis, descriptive or inferential statistics) to meet the project objective(s).
7.3.1- If descriptive statistics are proposed, state what tables, plots, and/or statistics (e.g., mean, median, standard error, minimum and maximum values) will be used to summarize the data.
7.3.2- If an inferential method is proposed, indicate whether the method will be a hypothesis test, confidence interval, or confidence limit and describe how the method will be performed.
7.4 Describe data storage requirements for both hard copy and electronic data.

**8. REPORTING**

8.1 List and describe the deliverables expected from each project participant.
8.2 Specify the expected final product(s) that will be prepared for the project (e.g., journal article, final report, etc.). If a method/SOP will be developed, specify the required format.

**9. REFERENCES**

Provide references either in the body of the text as footnotes or in a separate section.